OLCF Seminar Series

Scientific and Computational Challenges of the Fusion Simulation Program (FSP)

May 18, 2010

1:00 p.m.

Bldg.5100 Room 128

HOST: Ricky Kendall (kendallra@ORNL.GOV

Note: If you would like to request a meeting with the visitor, please contact Sherry Hempfling (hgv@ornl.gov)

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Abstract. This presentation will highlight the scientific and computational challenges facing the Fusion Simulation Program (FSP) – a major national initiative with the primary objective being to enable scientific discovery of important new plasma phenomena with associated understanding that emerges only upon integration. This requires developing a predictive integrated simulation capability for magnetically-confined fusion plasmas that are properly validated against experiments in regimes relevant for producing practical fusion energy. It is expected to provide a suite of advanced modeling tools for reliably predicting fusion device behavior with comprehensive and targeted science-based simulations of nonlinearly-coupled phenomena in the core plasma, edge plasma, and wall region on time and space scales required for fusion energy production. As such, it will strive to embody the most current theoretical and experimental understanding of magnetic fusion plasmas and to provide a living framework for the simulation of such plasmas as the associated physics understanding continues to advance over the next several decades. Substantive progress on answering the outstanding scientific questions in the field will drive the FSP toward its ultimate goal of developing the ability to predict the behavior of plasma discharges in toroidal magnetic fusion devices with high physics fidelity on all relevant time and space scales. From a computational perspective, this will demand computing resources in the petascale range and beyond together with the associated multi-core algorithmic formulation needed to address burning plasma issues relevant to ITER – a multibillion dollar collaborative experiment involving seven international partners representing over half the world's population. Even more powerful exascale platforms will be needed to meet the future challenges of designing a demonstration fusion reactor (DEMO). Analogous to other major applied physics modeling projects (e.g., Climate Modeling), the FSP will need to develop software in close collaboration with computers scientists and applied mathematicians and validated against experimental data from tokamaks around the world. Specific examples of expected advances which are needed to enable such a comprehensive integrated modeling capability and possible "co-design" approaches will be discussed.

BIO: William Tang is the *Director of the Fusion Simulation Program* at the Princeton Plasma Physics Laboratory (PPPL), the U. S. Department of Energy (DoE) national laboratory for fusion research. He is a Fellow of the American Physical Society, and on October 15, 2005, he received the Chinese Institute of Engineers-USA (CIE-USA) Distinguished Achievement Award. The CIE-USA, which is the oldest and most widely recognized Chinese-American Professional Society in North America, honored him “for his outstanding leadership in fusion research and contributions to fundamentals of plasma science.” He has been a Principal Research Physicist at PPPL and *Lecturer with Rank & Title of Professor in the Department of Astrophysical Sciences* since 1979, served as Head of the PPPL Theory Department from 1992 through 2004, and was the Chief Scientist at PPPL from 1997 until 2009. He also played a prominent national leadership role in the formulation and development of the DoE’s multi-disciplinary program in advanced scientific computing applications, SciDAC (Scientific Discovery through Advanced Computing). For the next two years he will be the PI (Principal Investigator) leading a national multi-disciplinary, multi-institutional team of plasma scientists, computer scientists, and applied mathematicians from 6 national laboratories, 2 private industry companies, and 9 universities to carry out the program definition and planning of DoE’s Fusion Simulation Program (FSP).

In research activities, Dr. Tang is internationally recognized for his leading role in developing the requisite mathematical formalism as well as the associated computational applications dealing with electromagnetic kinetic plasma behavior in complex geometries. He has over 200 publications – with more than 125 peer-reviewed papers in Science, Phys. Rev. Letters, Phys. Fluids/Plasmas, Nuclear Fusion, etc. and an “h-index” or “impact factor” of 42 on the Web of Science, including over 5300 total citations. He has guided the development and application of the most widely recognized codes for realistically simulating complex transport dynamics driven by microturbulence in plasmas and is currently the Principal Investigator of a multi-institutional DoE INCITE Project on “High Resolution Global Simulations of Plasma Microturbulence.” The INCITE (Innovative and Novel Computational Impact on Theory and Experiment) Program promotes cutting-edge research that can only be conducted with state-of-the-art super-computers. Prof. Tang has also been a key contributor to teaching and research training in Princeton University’s Department of Astrophysical Sciences for over 30 years and has supervised numerous successful Ph.D. students, who have gone on to highly productive scientific careers. Examples include recipients of the prestigious Presidential Early Career Award for Scientists and Engineers (PECASE) in 2000 and 2005.